

# Forestry APPLICATIONS

**S**atellite data, such as Landsat, SPOT, and AVHRR, have already been used by forestry firms and agencies to identify and analyze forest types, cut units, stand ages, streams, roads, and other boundaries. This information is then used a number of ways, including planning future cut blocks, post-harvest regeneration planting, construction of roads, as well as managing pest or fungus infestations.

Today, forestry organizations are concerned with managing entire ecosystems, not just trees, so assessing environmental conditions and changes has become an important part of preserving biodiversity. Ecosystem management expands the need to monitor and analyze changes in drainage, habitats, wildlife biology, and many other variables over time, especially as regulatory compliance becomes increasingly more challenging. ESE data will allow consistent monitoring over large regions and provide up-to-date information for the forestry industry.

Current and potential uses of satellite remote sensing data for forestry are listed below. In the Forestry Applications Matrix, the rows correspond to specific applications, and the columns correspond to individual ESE instruments. The potential use of data from a given ESE instrument for a specific forestry application is denoted by a check mark in the matrix.

## Forestry Applications Matrix

Application	ESE Instrument												
	MODIS	ASTER	Landsat7	MISR	CERES	TMI	PR	EOS Models	SeaWiFS	SRTM	AMSR	AIRS/ AMSU/ MHS	ESSP VCL
Measuring Timber Acreage		✓	✓										
2 Classifying Forest Age, Seral Stages, and Timber Type	✓	✓	✓	✓									✓
Monitoring and Planning Forest Harvest		✓	✓										
4 Monitoring and Mitigating Timber Disease	✓	✓	✓	✓									
Monitoring Forest Fire and Assessing Fire Hazard	✓	✓	✓	✓		✓		✓	✓		✓		
6 Analyzing Watersheds	✓	✓	✓	✓						✓			✓
Understanding Forestry Infrastructure and Transportation		✓	✓										
8 Analyzing Droughts and Floods	✓	✓	✓	✓		✓	✓	✓	✓		✓		
Monitoring Soil Erosion	✓	✓	✓						✓	✓			✓
10 Mapping and Monitoring Wetlands	✓	✓	✓	✓					✓				✓
Estimating Global and Regional Deforestation	✓	✓	✓						✓				
12 Studying the Environmental Impact	✓	✓	✓	✓					✓				

## 1 Measuring Timber Acreage

Commercial imagery, from satellites like Landsat and SPOT, is currently being used in combination with aerial photographs to make specific estimates of timber acreage. Soon, high-resolution ASTER and Landsat 7 data will add to the available data, including forest cartography and tree species classification. Traditional mapping techniques cannot keep up with the degree of change that occurs in a forest. Values of up to \$25,000 per acre make precise measurement of timber acreage crucial to the forester.

Digital topographic data derived directly from ASTER will enable precise estimates of topographic slopes and elevations at a resolution equal to or better than the best available maps. Accurate terrain information helps both minimize planting/harvesting costs and predict runoff and soil erosion.

## 2 Classifying Forest Age, Seral Stages, and Timber Type

Data from MODIS and MISR can be used to characterize forest and timber type by providing high spectral resolution and precise angular reflectance functions. This information can then be used by forest managers to deploy species-specific harvesting strategies that lead to maximum timber supply.

Mapping stages supports forest ecosystem management. Researchers have found that spectral reflectance decreases as the forest ages and develops a canopy. ESE data will enable researchers to more precisely determine these parameters.

## 3 Monitoring and Planning Forest Harvest

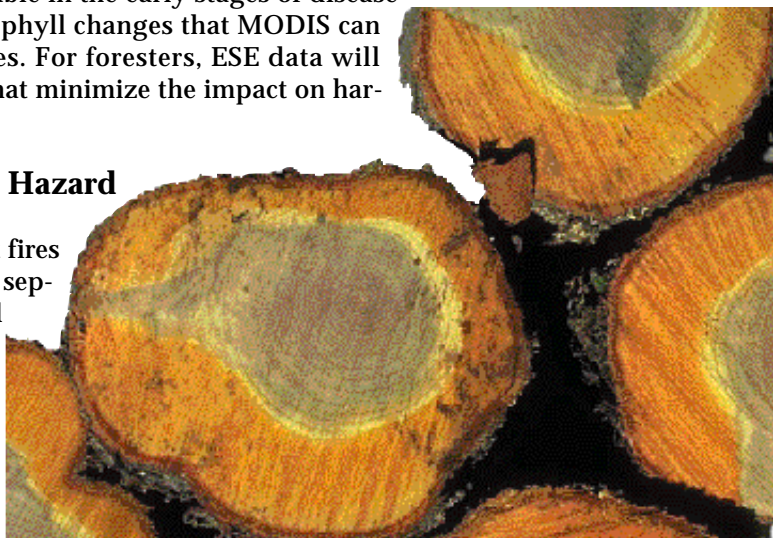
In the future, field-based tree counting, the current basis of harvest estimates, may be augmented by integrating ASTER and Landsat 7 data with data collected in the field. The field studies will be used to calibrate the satellite imagery, thus enabling more reliable and uniform regional tree density mapping. Data from ASTER and Landsat 7 could later be used to plan replanting of harvested areas.

## 4 Monitoring and Mitigating Timber Disease

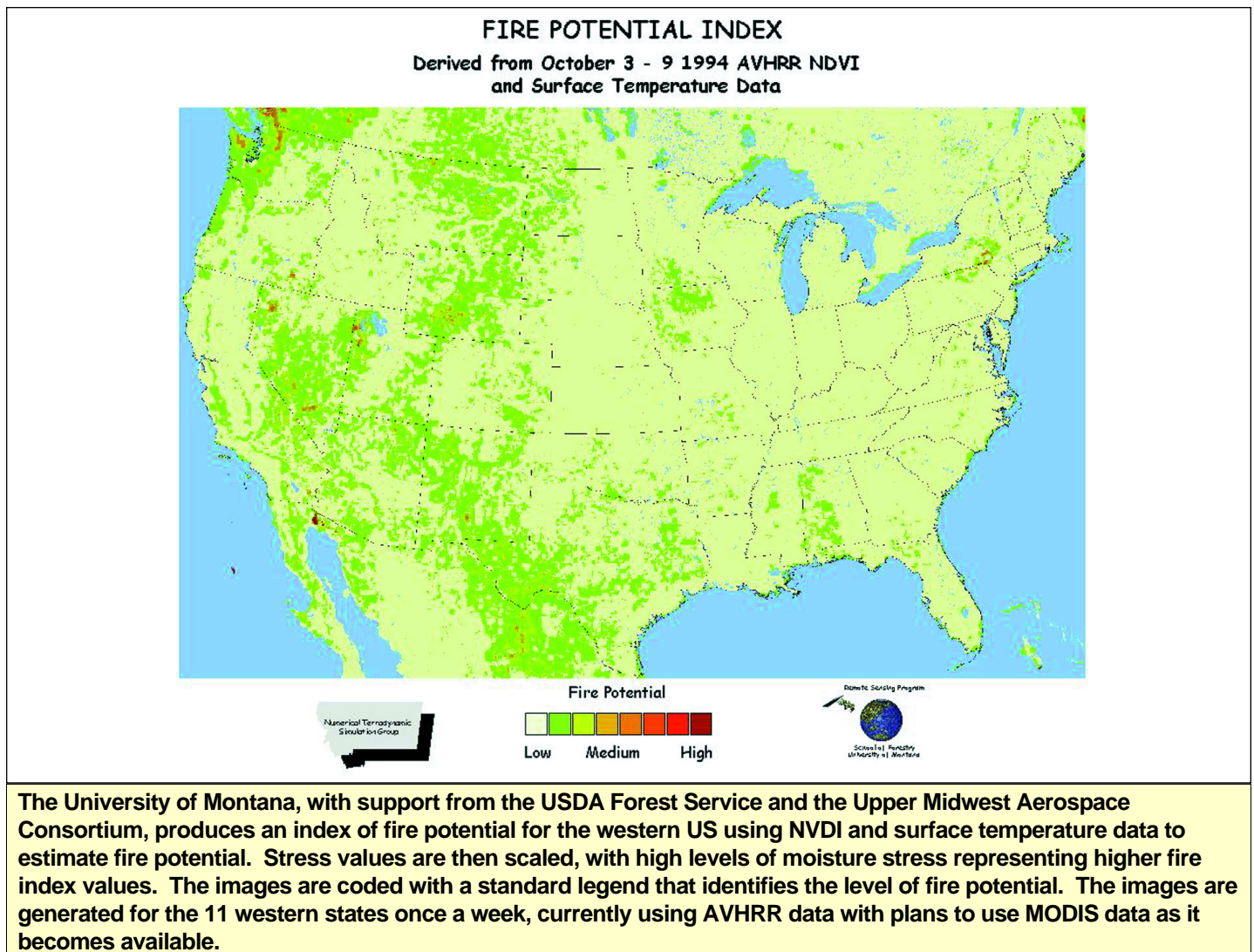
Mapping and monitoring timber disease is a proven remote sensing application in forestry. With the addition of ESE instrument data, tree stress will be more easily detectable in the early stages of disease development, which is characterized by subtle chlorophyll changes that MODIS can detect and more precisely map during the later stages. For foresters, ESE data will guide disease containment and mitigation strategies that minimize the impact on harvest quantity and quality.

## 5 Monitoring Forest Fire and Assessing Fire Hazard

Some of the most challenging aspects of fighting forest fires include coping with large numbers of fire centers often separated by great distances, with complex terrain and hostile ground conditions, and without reliable fire maps. Satellite data could help. In 1988, for example, satellite data were used extensively in the fight against the Yellowstone forest fires. The MODIS, ASTER, and Landsat 7 instruments are specifically adapted to provide precise images of surface fires. In combination with other instruments, MODIS will



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produce soil moisture and vegetation maps that can be used for better fire hazard prediction by providing data that researchers may use to assess the fire fuel volatility of different vegetation types.

## 6 Analyzing Watersheds

ESE data may be used in forest management systems to help identify existing watershed conditions and also to predict potential problems associated with various forestry activities, including how harvesting will alter the landscape or how rivers and streams will be impacted by changes in runoff that accompany tree removal in drainage basins.

## 7 Understanding Forestry Infrastructure and Transportation

Satellite imagery, including some from Landsat, are already being incorporated into many forestry GIS systems, along with Digital Elevation Models, to provide information on terrain, drainage, and vegetation extent. This information is then used to plan the optimal road construction and logging routes.



## 8 Analyzing Droughts and Floods

Precipitation, soil moisture, land cover, and land use change data will be routinely gathered by ESE instruments. Over the southern part of the U.S. (south of 35 degrees north latitude), instruments from the TRMM mission measure soil moisture and precipitation directly. Over the rest of the U.S., soil moisture will be estimated through synthesis of observations and ESE models.

The MODIS, ASTER, and Landsat 7 instruments will collect data on land use and land cover change. Data analysis will aid commercial foresters by providing planning information to help minimize the cost impact of flood damage. Flood modeling will allow foresters to formulate harvest strategies to minimize loss in the event of catastrophic floods and help with the logistics of deploying emergency response crews. In addition, drought prediction and analysis could reduce the cost associated with loss of trees during their vulnerable early growth stages by providing information to influence tree health maintenance and watering strategies.

## 9 Monitoring Soil Erosion

SeaWiFS provides data on the sediment content of runoff, which will enable more reliable soil erosion estimates in estuaries, bays, and lakes. MODIS also features excellent spectral resolution in the near-infrared, allowing precise determination of sediment concentrations in these regions. The high spatial resolution of ASTER and Landsat 7 permit monitoring sediment concentration in smaller rivers and lakes.

## 10 Mapping and Monitoring Wetlands

Soil moisture data provided by AMSR and TMI passive microwave instruments allows researchers to assess wetlands state and variability. MISR will aid in mapping regions of shallow water cover that might be missed by conventional visible/near-infrared sensors.

## 11 Estimating Global and Regional Deforestation

The Food and Agriculture Organization of the United Nations (FAO) and U.S. Forest Services are already using satellite data from Landsat and AVHRR to make estimates of deforestation rates, especially in the tropics. The increased availability and number of images will allow these types of estimates to be made more frequently.

## 12 Studying the Environmental Impact

MODIS, ASTER, and Landsat 7 data will help keep costs down and support effective environmental impact studies by improving the precision, accuracy, and timeliness of environmental maps, for example, leading to development of timbering strategies that minimize erosion.

